# 5 Site Characteristics

The Mine Area Operable Unit covers approximately 30 acres in a forested area of the Sierra Nevada foothills southeast of Nevada City and east of Grass Valley, Nevada County, California, comprising the historic mine property and several contiguous parcels of land which have been impacted by mining activities. It also incorporates a narrow band of property along the banks of Little Clipper Creek from the location of the failed log dam (to the north) to the point at which the creek crosses beneath Greenhorn Road (to the south). Large rural residential lots surround the mine. The now-inoperative mine is situated on the southern slope of Banner Ridge. The elevation at the central mine shaft is about 2,840 feet above sea level and drops off rapidly toward the southern property boundary. The property which comprises the Mine Area Operable Unit is located within the Little Clipper Creek drainage basin, which drains to the south away from the mine. (See Figure 4/Mine Features and Major Source Areas; and Figure 5/Little Clipper Creek Source Area).

The site characteristic information presented in this section is also available in greater detail in the Remedial Investigation (RI) and Feasibility Study (FS) Reports (USEPA 2001a and 2004a, respectively). To determine the nature and extent of contamination at the Site, USEPA conducted three main rounds of data gathering, in October-November 1999, January 2000, and May-June 2000. Media sampled at the Site included groundwater, surface water, soil, and sediment. These media were sampled at both suspected source areas and also at "reference" or "background" locations unaffected by historical Site activities. Supplementary data collection events were also subsequently conducted to address additional questions that arose from data collected during the three main sampling events. Because this ROD only addresses cleanup of the Mine Area Operable Unit, only data collected from that portion of the Site are addressed here.

Sampling efforts at the Mine Area Operable Unit were guided by visual evidence of historic mining and mine waste disposal activities and also by the results of by previous investigations conducted by CA/DTSC and the screening level investigations conducted during the pre-listing Superfund Site Investigation process. Source areas identified by these processes of evaluation were as follows: process buildings; disposal areas composed of waste rock and tailings; other disturbed areas where the surface soils resemble the processed mine tailings; water emanating from the mine and the disposal areas; and surface drainages where sediment resembling the processed mine tailings exists.

In chemical terms, the sampling effort included broad screening of the categories of contaminants that would be expected to occur as a result of hardrock mining operations, including: metals and inorganic constituents present in processed native ore and any chemicals added during the processing of ore. Data collected by State regulatory authorities prior to the listing of the Site on the NPL pointed to arsenic and other metals being the likely contaminants of concern. Chemical constituents that are commonly introduced during processing of ore were considered, including mercury (used in gold and silver amalgamation processes) and cyanide (used in recovering gold and silver from waste tailings). Although few organic constituents were generally in use during the era of mining operations at the Site, USEPA did conduct limited sampling for organic constituents and confirmed they were not present.

For the purposes of developing and evaluating cleanup alternatives, USEPA divided the Mine Area Operable Unit into three subareas because of their unique characteristics (terrain and contaminant sources present). The data collected during USEPA's studies will be discussed in greater detail below in terms of the three subareas: 1) mine area residences; 2) mine buildings, tailings, waste rock, contaminated mine drainage; 3) areas of Little Clipper Creek downstream of the mine but upstream of Greenhorn Road (Greenhorn Road being the southern boundary of the Operable Unit).

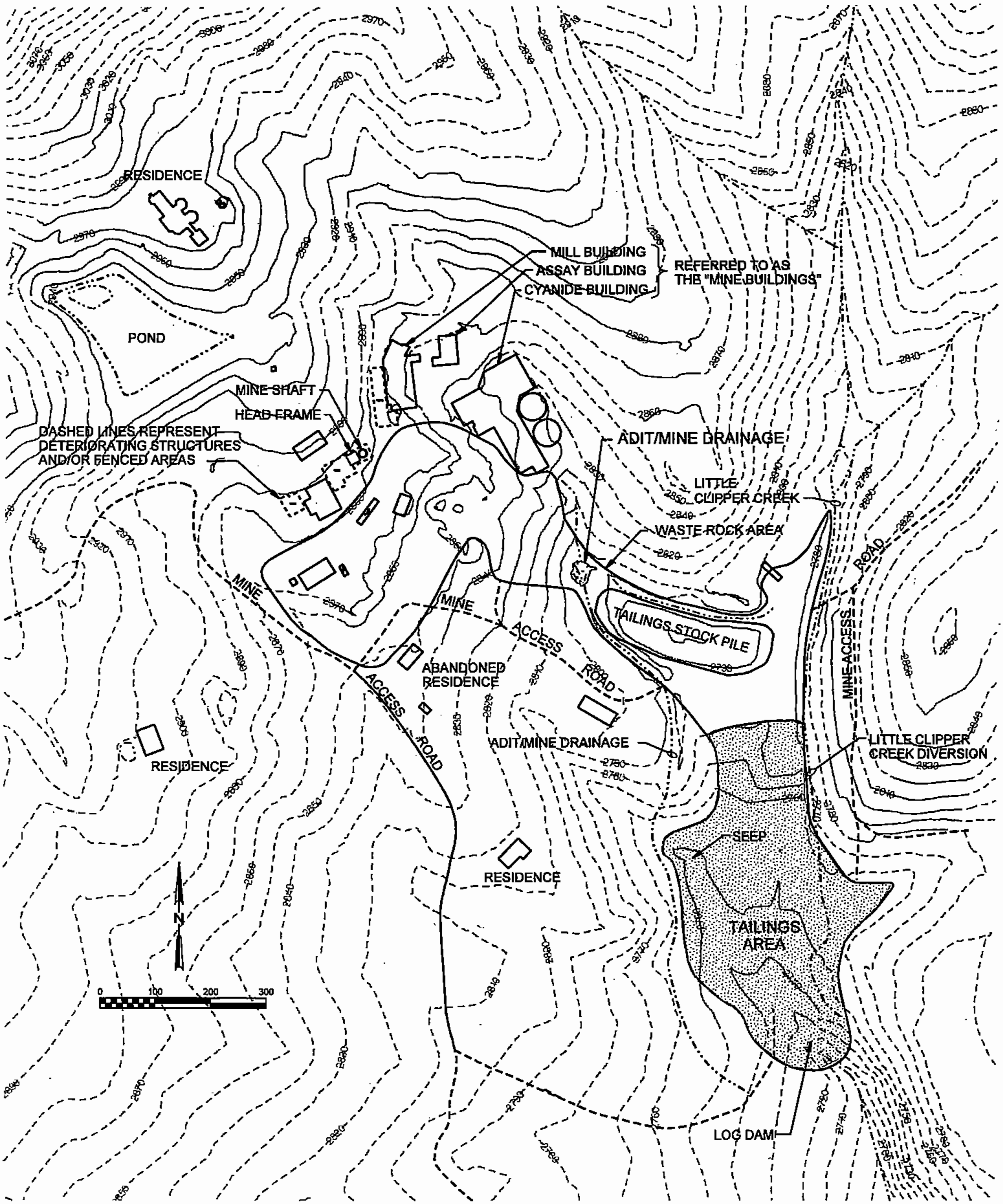


FIGURE 4
MINE FEATURES AND MAJOR SOURCE AREAS
LAVA CAP MINE
NEVADA COUNTY, CALIFORNIA

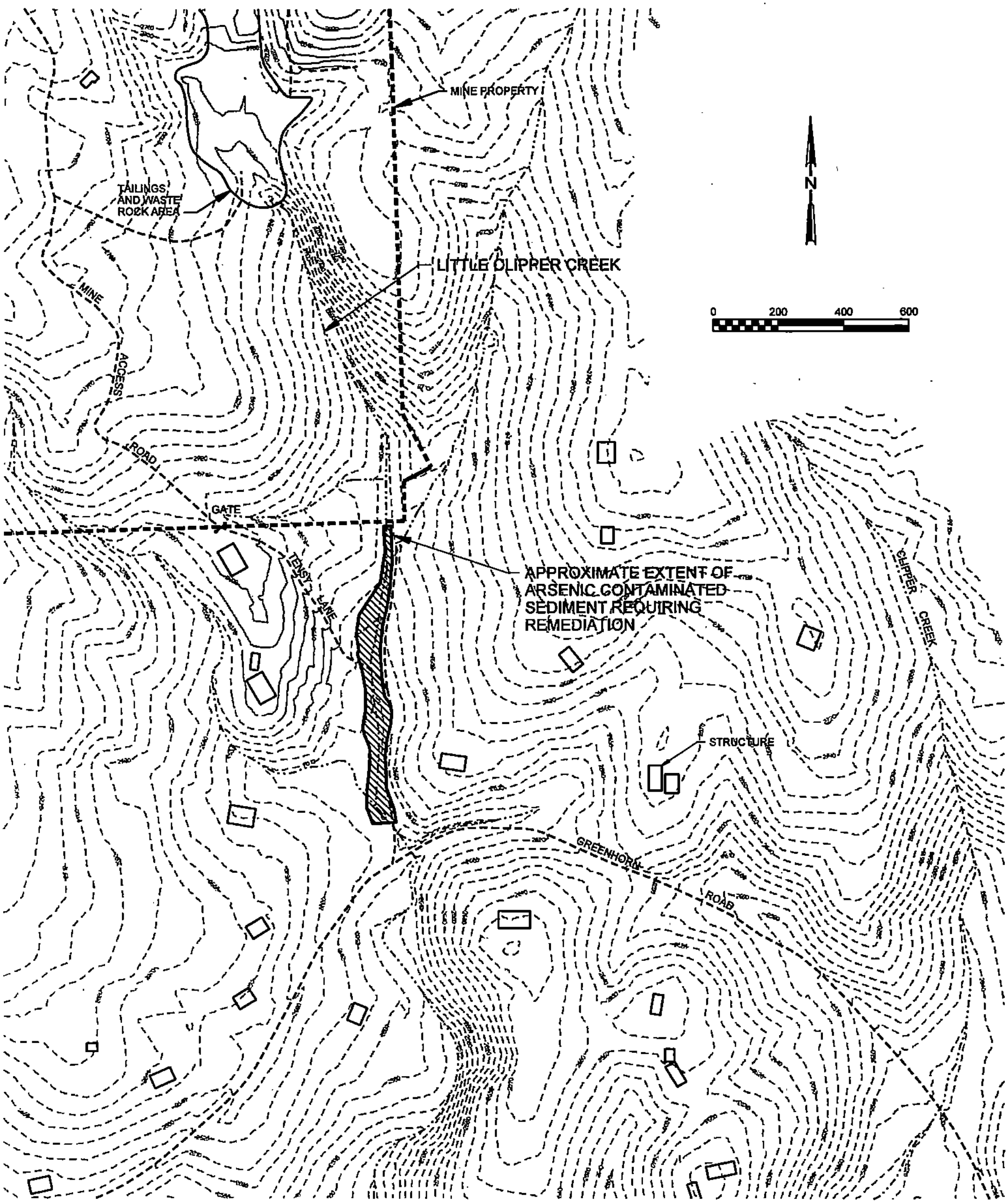


FIGURE 5
LITTLE CLIPPER CREEK SOURCE AREA
LAVA CAP MINE
NEVADA COUNTY, CALIFORNIA

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# 5.1 Background Levels of Contamination

USEPA's approach to establishing background concentrations (See Table 1) for the Lava Cap Mine Superfund Site followed the framework set forth by CA/DTSC in the *Final Policy of Selecting Inorganic Constituents as Chemicals of Potential Concern at Risk Assessments at Hazardous Waste Facilities and Permitted Facilities* (DTSC, 1997). The guidance defines "ambient conditions" as concentrations of metals in media in the vicinity of a site but which are unaffected by site-related activities. Ambient conditions are also referred to as "local background". The CA/DTSC guidance states that when few data are available to describe background conditions (i.e., less than 20 samples), both the shape of the background distribution and its upper extremes are uncertain and the value representative of ambient conditions should be a measure of central tendency, such as the arithmetic mean or an upper confidence interval around the mean. When ambient conditions are well described, (i.e., sample sizes are larger and the distribution is well defined), an estimate of an upper percentile of the ambient distribution, such as the upper 95$^{th}$ or 99$^{th}$ percentile, may be used.

| Media | Number of Samples | Background Level | Statistical Basis |
|---|---|---|---|
| surface soil | 18 | 20.0 milligrams per kilogram (mg/kg) or parts per million (ppm) | Maximum Detection(essentially the same as the 95$^{th}$ Percentile). |
| surface water | 24 | 1.8 micrograms per liter ($\mu$g/L) or parts per billion (ppb) | 95$^{th}$ Percentile |
| groundwater | 8 | 18.0 ppb | 95$^{th}$ Upper Confidence Limit (UCL) of the Mean |
| sediment | 13 | 24.6 ppm | 95$^{th}$ UCL of the Mean |

**Table 1: Background Levels of Arsenic in Various Media**

The background data set for the Site was created by combining data collected between October 1999 and November 2002 from the three reference areas: Reference Area 1 (upgradient of the mine), Reference Area 2 (Clipper Creek upgradient of the confluence with Little Clipper Creek), and Reference Area 3 (Little Greenhorn Creek upgradient of the confluence with Clipper Creek). Three soil samples were excluded from the background data set because they were not considered to be representative of ambient conditions, i.e. it was determined that they were obtained from areas disturbed by human influence, possibly including fill and/or road building activities using waste rock and potentially mine tailings.

The background data sets were tested for normality using the Shapiro-Wilk test, as described in the USEPA guidance *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities Addendum to Interim Final Guidance* (USEPA, 1992a). The 95 percent UCL of the mean was calculated for data that best fit a normal distribution. For data that best fit a lognormal distribution, the 95 percent UCL was also calculated using the Land method as described in the USEPA guidance *Supplemental Guidance to RAGS: Calculating the Concentration Term* (USEPA, 1992b). The Land approach was found to be sensitive to deviations from lognormality and small sample sizes. UCLs calculated using the Land method for lognormally distributed data were much greater than UCLs calculated using assumptions of normality, and in many cases, were greater than the maximum detected concentration in the background data set. Because the lognormal UCL values were not as conservative, the 95 percent UCL was calculated for all data sets assuming a normal distribution.

The 95th percentile of the population was selected as the background value for the surface soil data sets, which contained 18 data points after the outliers had been removed. In most cases, the surface soil data were found to fit a normal distribution. The 95th percentile of the population was also selected as the background value for the surface water data set comprised of 24 unfiltered samples. The 95 percent UCL of the mean, calculated using the assumptions of normality as described above, was selected as the background value for the smaller groundwater and sediment data sets.

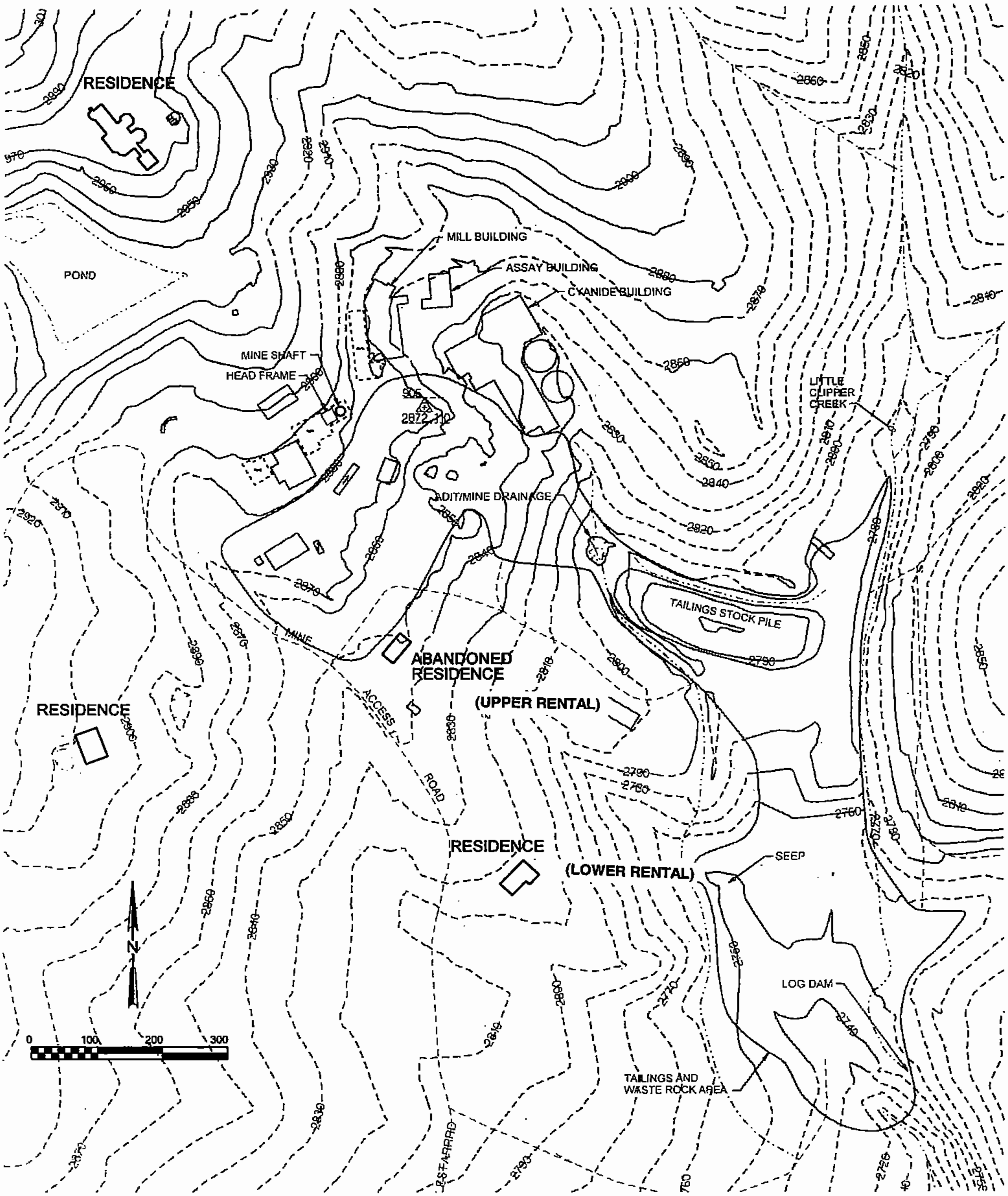
The final determination of the background value included a comparison of the selected UCL or 95th percentile value to the maximum concentration detected in the background samples. If the maximum concentration detected was less than the UCL or percentile value, the maximum concentration was chosen to represent background rather than the statistically-based number.

## 5.2 Mine Area Residences

A total of four residences, one of which may date back to the period of active mining at the Site, and three others that are of more recent vintage, have up until recently been maintained and inhabited at the Mine Area Operable Unit (See Figure 6/Mine Area Residences). As of the date of this ROD only two of these homes are occupied, the occupants of the other two having been relocated as part of a response action taken by USEPA (see Section 2).

The oldest residence is a rustic cabin located in closest proximity to the mine buildings and is referred to as the "Upper Rental". It appears to have been built on top of waste rock and is located directly adjacent to the tailings disposal area. Sampling of surface soils around this residence revealed levels of arsenic as high as 1,750 ppm. In comparison, levels of arsenic in samples taken from surface areas of the waste rock and tailings disposal areas averaged 1,336 ppm, suggesting that there are mine tailings located directly adjacent to the Upper Rental. For the purposes of developing a preliminary indication as to whether a risk may exist at a Superfund site, USEPA Region 9 has developed media-specific contaminant screening levels called preliminary remediation goals (PRGs) (USEPA, 2003a). Different PRGs have been established for different exposure scenarios (e.g., residential versus industrial) and for some contaminants a PRG exists for both non-cancer risks and cancer risks. For arsenic in soil under a residential exposure scenario, the non-cancer PRG is set at 22 parts per million (the cancer PRG is orders of magnitude lower and well below arsenic background levels). Arsenic levels in soil that are above background levels in soil (see Table 1) and above USEPA's PRG suggest that cleanup may be necessary. As can be seen from the data referenced above, levels of arsenic in soil adjacent to the Upper Rental are almost 80 times higher than the PRG. USEPA considers the Upper Rental unsafe to live in under present conditions. USEPA relocated the sole occupant in 2003, and has determined that it will be necessary to demolish the residence as part of the cleanup (see Section 12).

Another residence is located a little further to the south of the mine buildings but within approximately 300 feet of the main tailings pile and is referred to as the "Lower Rental". Sampling of surface soil around this residence revealed levels of arsenic as high as 1,230 parts per million, which again is a level similar to that found in surface soil at the main disposal areas. USEPA also considers this residence unsafe to live in at present. In 2004, USEPA relocated the family inhabiting the residence. During implementation of the Mine Area remedy USEPA will make a final determination as to whether arsenic in soil can be cleaned up to a point where the Lower Rental is suitable for future residential use; preliminary indications are that the parcel can be remediated to permit future residential use.




NOTE:
THE ABANDONED RESIDENCE IS CONSIDERED PART OF THE WASTE ROCK AND TAILINGS AREA.

FIGURE 6
MINE AREA RESIDENCES
LAVA CAP MINE
NEVADA COUNTY, CALIFORNIA

The other two residences are located a considerable distance from the main contamination sources. Sampling was also conducted in these locations and it was determined that arsenic levels there are still elevated in comparison to background levels. These levels are not considered high enough to warrant relocation of the residents in the short term. However because they exceed USEPA's cleanup goals, remediation of contaminated soil will be necessary as discussed in Section 12.2.1 below.

The total volume of soil containing arsenic in excess of health-based levels in these residential areas is estimated at 2,700 cy. In the long term, these soils containing elevated levels of arsenic will need to be managed as part of the overall cleanup, as described in Section 12.2.1.

The COC that drives human health risk for this subarea is arsenic (see Table 2). Iron and lead were also noted as COCs for this residential scenario. Whereas arsenic is a known human carcinogen, iron and lead are not.

| COC | Human Health | Ecological Health |
|---|---|---|
| Antimony | no | yes |
| Arsenic | yes | yes |
| Cadmium | no | yes |
| Cobalt | no | yes |
| Copper | no | yes |
| Cyanide | no | yes |
| Iron | yes | no |
| Lead | yes | yes |
| Manganese | no | yes |
| Mercury | no | yes |
| Nickel | no | yes |
| Selenium | no | yes |
| Silver | no | yes |
| Zinc | no | yes |

**Table 2: Contaminants of Concern in Soil and Sediment**

Although groundwater at the Site is being investigated under a separate Groundwater Operable Unit, some discussion of its occurrence is warranted here. Fractures and joints in the bedrock (and also the constructed network of shafts and tunnels) underlying the Mine Area contain groundwater which is considered a potential source of drinking water. This local bedrock system appears to be connected with the greater regional aquifer system that is the source of domestic drinking water at and in the Site vicinity. The mine tailings and waste rock overlying the bedrock contain shallow saturated zones showing measurable levels of arsenic, and water emanating from the mine workings also contains measurable levels of arsenic. Groundwater monitoring shows that the aquifer system as a whole also contains "background" or naturally occurring levels of arsenic. Therefore without further study it is not know the degree to which the Site is contributing to arsenic in groundwater. However, it is known that levels of arsenic in local domestic water supply wells on the mine property appear to be higher than the aforementioned "background" levels (see Table 1), which suggests the mine may be contributing to elevated levels of arsenic within the aquifer.

## 5.3 Mine Buildings, Tailings, Waste Rock, and Mine Drainage

The most pronounced surface features at the Mine Area Operable Unit consist of the mine buildings and the waste rock and tailings piles (see Figure 7/Mine Buildings, Waste Rock, Tailings Area, Mine Drainage). The waste rock and tailings piles comprise a disposal area of several acres of the mine property near the central mine shaft. Geologically speaking, the Sierra Nevada physiographic province in which the Site lies is characterized by intrusive and volcanic rock as well as metamorphosed sedimentary rock. The waste rock found at the surface of the Site is a mixture of the various types of meta-sedimentary, igneous intrusive, and meta-volcanic rock underlying the Site; this waste rock was not processed through the stamp mill because it did not contain sufficient quantities of gold and silver, therefore it was discarded. Although the waste rock contains arsenic, it continues to be bound up in the rock matrix and does not appear to be readily available to the environment.

In contrast, the tailings consist of finely ground rock of similar type. These tailings range in composition from fine sand to silty clay, and appear dark gray where wet and unoxidized, lighter in color where weathered. The gold and silver occurred in quartz veins intrusive to the metasedimentary rock. As the native ore bodies contained significant quantities of arsenic, and as processing of the ore did not alter the arsenic, it remains present in the tailings in significant quantities and in a form that is available to the environment.

Photo 4: Head frame c. 2003

Arsenic concentrations in surface soil taken from the tailings and waste rock disposal areas averaged 1,340 ppm. Again, this level greatly exceeds the PRG of 22 ppm (see Section 5.2 for a discussion of the meaning of the PRG value). The volume of waste tailings in the Mine Area is estimated at 50,000 cy and the volume of waste rock is estimated at 160,000 cy.

Several structures are present at the Mine Area. The head frame is still visible above the central shaft (see Photo 4). Horizontal access to Lava Cap Mine was through an adit, or entrance, connected by a tunnel to the central shaft; this adit has collapsed during the intervening years since the mine ceased to operate in 1943. Large timber frame and sheet metal sheathed buildings that formerly housed the stamp mill, flotation plant, cyanide treatment facility, assay office, and storerooms, are in varying states of disrepair.

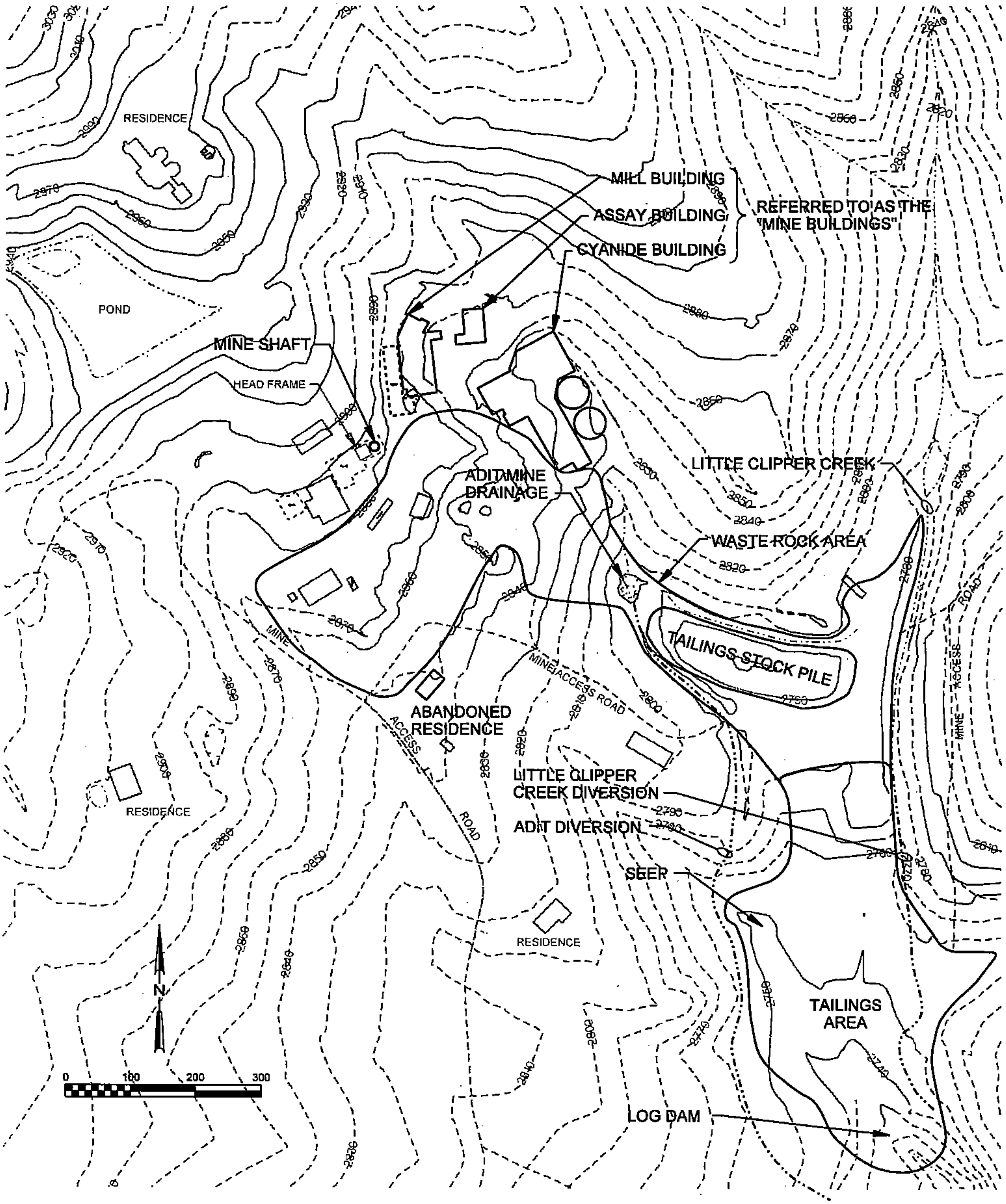



FIGURE 7
MINE BUILDINGS, WASTE ROCK, TAILINGS AREA, MINE DRAINAGE
LAVA CAP MINE
NEVADA COUNTY, CALIFORNIA

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Arsenic concentrations of up to 31,200 ppm were found in surface soil within and around the cyanide and mill buildings. Cyanide concentrations of up to 419 ppm were detected in soil samples in and around the cyanide building (this is by far the most significant concentration of cyanide found at the Site; levels elsewhere are below health screening levels).

Water discharges to the surface continuously from the mine workings through the caved-in adit entrance. (See Photo 5.) Under normal, non-storm conditions, the flow rate from the adit has been measured in the range of 50 to 200 gallons per minute (gpm). Under these discharge conditions arsenic levels in water have registered as high as 910 ppb. For comparison, the federal primary drinking water standard, or Maximum Contaminant Level (MCL) for arsenic has been set at 10 ppb. During the rainy season, flow at the adit increases (it has been measured by USEPA as high as 1,800 gpm) and concentrations of arsenic decrease (but remain at or above 200 ppb). Rainy season flows at the adit are believed to include a component of surface runoff in addition to mine drainage. In 1997 USEPA captured and began diverting flow from the adit to a point in Little Clipper Creek downstream of the damaged log dam. Flows in Little Clipper Creek originating upstream of the mine are also currently being diverted around the tailings pile and dam.

**Photo 5: Caved-in adit c. 2004**

Water also flows continuously out of the base of the damaged log dam (at rates ranging from 20 gpm during the dry season up to 300 gpm during the rainy season). This flow is believed to be primarily comprised of surface runoff that has entered the waste rock and tailings piles and seeps through the disposal area. This flow also shows elevated levels of arsenic (ranging from 80 ppb in the wet season to 270 ppb during the dry season). The water flowing out of the base of the log dam enters the historic Little Clipper Creek stream channel. Again, the COC that drives human health risk is arsenic. Lead and iron are also considered COCs for this exposure scenario.

# 5.4 Little Clipper Creek Downstream of the Mine and Upstream of Greenhorn Road

Historically, mine tailings left the mine property through the Little Clipper Creek drainage and collected in various low-lying or flat locations of the drainage downstream of the mine (see Figure 5). One such location where tailings were deposited is located directly to the north of Greenhorn Road. These localized deposition areas occur on what are now residential parcels; however the houses themselves are built some distance from the creek and at an elevation above the creek. Therefore, the only contact persons would be expected to have with the tailings in these areas would occur through recreational exposure. Nevertheless, USEPA considers levels of arsenic found in the sediments in the drainage to be unhealthful (averaging 669 ppm). An estimated area of an acre or less is impacted, containing an estimated total volume of tailings of 2,000 cy. Recreational users of Little Clipper Creek are also expected to come into contact with contaminated surface water through wading. The COC that drives human health risk from surface water contact is arsenic (see Table 3). Lead and iron are not considered human health COCs for this exposure scenario.

| COC | Human Health | Ecological Health |
|---|---|---|
| Antimony | no | yes |
| Arsenic | yes | yes |
| Barium | no | yes |
| Beryllium | no | yes |
| Cadmium | no | yes |
| Cobalt | no | yes |
| Copper | no | yes |
| Cyanide | no | yes |
| Lead | no | yes |
| Manganese | no | yes |
| Mercury | no | yes |
| Nickel | no | yes |
| Silver | no | yes |
| Zinc | no | yes |

**Table 3: Contaminants of Concern in Surface Water**

# 5.5 Conclusions and Conceptual Site Model

The Conceptual Site Model identifies the mechanisms under which the contaminant sources which have been described above can result in releases to the environment, and the potential pathways that contaminants of concern could follow that could result in exposure to human and ecological receptors. For a graphic representation of the model see Figure 8/Conceptual Site Model.

The model indicates that potentially complete exposure pathways exist that could harm human health and the environment if Site contaminants are not addressed through remedial actions.

There are currently mechanisms at the Mine Area Operable Unit under which current residents, future construction workers, and current recreational users could be subject to unacceptable risks. Completed exposure pathways include dermal contact with contaminated soil or sediment; dermal contact with contaminated surface water; ingestion of contaminated soil or sediment; ingestion of contaminated surface water; and inhalation of contaminated soil/wind borne dust. Additionally, ingestion of, and

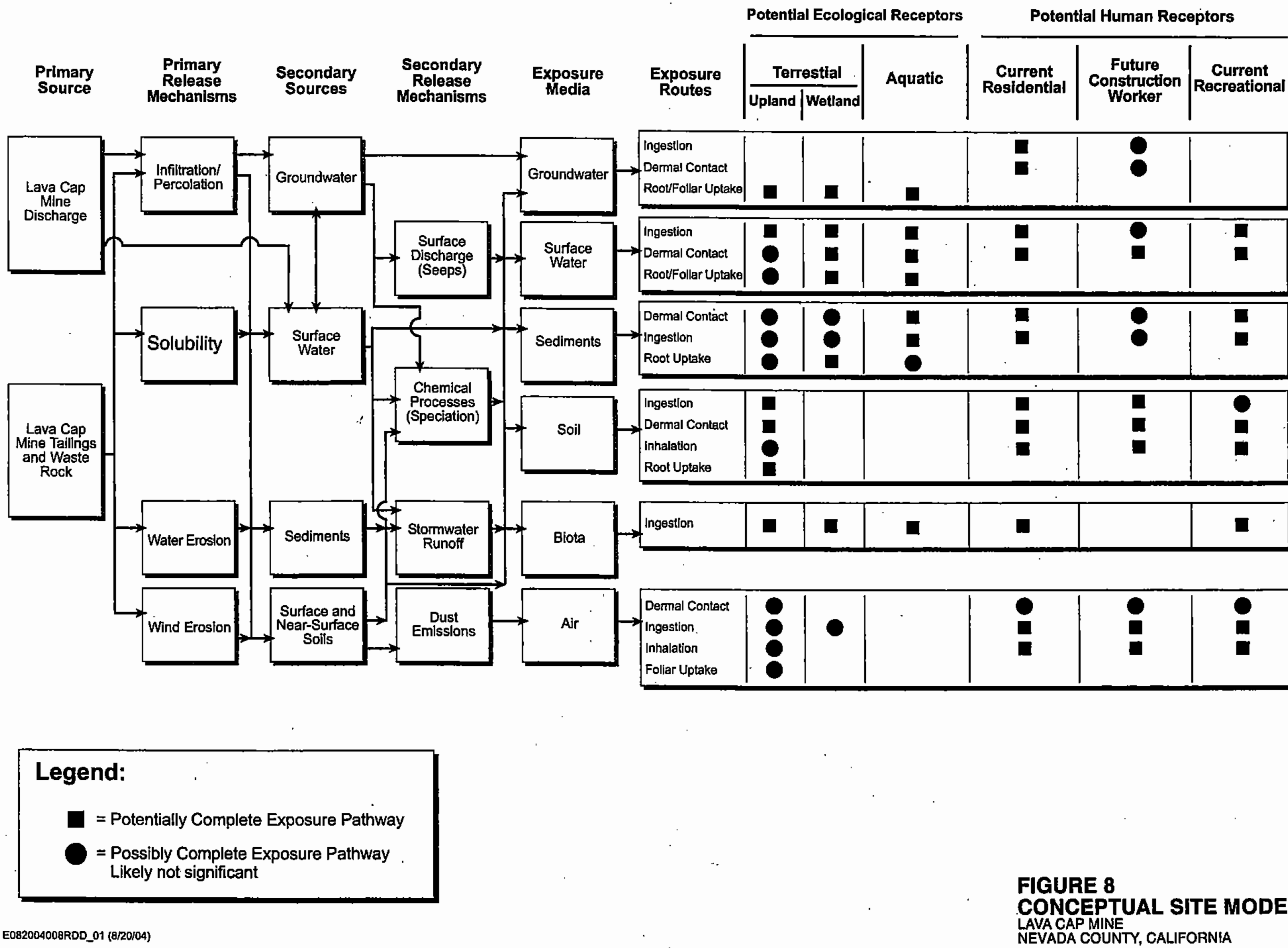


**FIGURE 8**
**CONCEPTUAL SITE MODEL**
LAVA CAP MINE
NEVADA COUNTY, CALIFORNIA

dermal contact with, contaminated groundwater is also possible in cases where residential wells in use contained elevated levels of arsenic.

There are also mechanisms in place through which terrestrial and aquatic ecological receptors could be subjected to unacceptable risks. Terrestrial receptors face such completed pathways as: ingestion of contaminated surface water and biota; and dermal contact with contaminated water, soil and sediment. Aquatic receptors face such completed pathways as: ingestion of contaminated surface water, sediment, and biota; and dermal contact with contaminated surface water and sediments.

## 5.6 Data Quality

As is the practice at federal Superfund sites, USEPA instituted a Quality Assurance/Quality Control (QA/QC) program for data collection at the Lava Cap Mine Superfund Site. The purpose of such a program is to ensure that the data collected during the investigation process is meaningful, and that the cleanup decisions made based upon the investigation's results are scientifically supportable. USEPA's review of the data quality procedures implemented at the Site concluded that proper laboratory analytical methods were used; proper sample collection procedures were followed in the field; the use of duplicate samples introduced a high degree of confidence in the data; and very few data points needed to be rejected due to concerns about their veracity. USEPA is confident that the data collected support the Mine Area Operable Unit cleanup adopted in this ROD.

# 6 Current and Potential Future Land and Resource Uses

## 6.1 Existing Land Use

The Mine Area Operable Unit includes both abandoned industrial process areas and residential areas. The Operable Unit includes seven parcels associated with the historic mine, and an additional two parcels not associated with the mine but on which mine tailings have been deposited by surface water transport from the mine.

The more complex area of the Mine Area Operable Unit is the historic mine property, which is divided into seven land parcels. All seven parcels are zoned with the Nevada County use designation RA-5 (Residential/Agricultural). The parcel numbers and a discussion of their current use is as follows.

Parcel 39-160-21, contains the private single family residence of the owner of the seven parcels. It appears that this parcel has historically been limited to residential use, although it appears based on visual evidence and environmental sampling that construction fill and/or road building activities have resulted in the placement of relatively small quantities of mine tailings on this parcel. The residence located on this parcel relies on a residential well on the same parcel for water supply. USEPA's monitoring program has shown water from this well consistently exceeds the MCL for arsenic of 10 ppb. There is currently a single-tap water treatment system connected in this household which was installed by the property owner. USEPA's monitoring program has shown that this treatment system has effectively reduced arsenic at the tap to a level below the MCL.

Parcel 39-160-16, contains one single family residence which is currently occupied as a rental unit. It appears that this parcel has historically been limited to residential use, although it appears based on visual evidence and environmental sampling that construction fill and/or road building activities have resulted in the placement of relatively small quantities of mine tailings on this parcel. The residence located on this parcel relies on a residential well on the same parcel for water supply. USEPA's monitoring program has shown water from this well consistently exceeds the MCL for arsenic of 10 ppb. There is currently a single-tap treatment system installed at this residence as a result of USEPA's response action taken in April 2003 (see Section 2). USEPA's monitoring program has shown that this treatment system has effectively reduced arsenic at the treated tap to a level below the MCL.

Parcel 39-160-25, which is the largest parcel, contains the mine's process buildings, and the main waste rock and tailings piles. It also contains one residence. This residence, referred to in this ROD as the Upper Rental, is currently unoccupied as the result of USEPA's response action taken in April 2003 (see Section 2). This is the parcel where the majority of the contaminated soil exists, and the parcel from which contaminated surface water emanates from the mine adit and from seeps at the tailings disposal area. The currently unoccupied residence located on this parcel in past has relied on a residential well located on parcel 39-160-16 for water supply. USEPA's monitoring program has shown water from this well consistently exceeds the MCL for arsenic of 10 ppb.

Parcel 39-160-30, which is located to the south of the parcel on which the historic mine buildings are located (39-160-25, discussed above), currently contains one residence, referred to as the Lower Rental. This residence is currently unoccupied as the result of USEPA's response action taken in April 2003 (See Section 2). It appears based on visual evidence and environmental sampling that construction fill and/or road building activities have resulted in the placement of removable quantities of mine tailings on this parcel. The currently unoccupied residence located on this parcel in past has relied on a residential well located on the same parcel for water supply. USEPA's monitoring program has shown water from this well consistently exceeds the MCL for arsenic of 10 ppb.

Parcel 39-160-27, which is located to the east of the parcel on which the historic mine buildings are located (39-160-25, discussed above), currently does not contain any residences, and appears to contain limited quantities of tailings at the westernmost corner of the parcel. It appears that the westernmost corner of the parcel is crossed by the existing Little Clipper Creek diversion structure.

Parcel 39-160-28, which is located to the south of, and which borders the tailings disposal area which occupies parcel 39-160-25 (discussed above), contains the failed log dam and an additional quantity of tailings. There are no residences located on this parcel.

Parcel 39-160-29, which is located to the south of parcel 39-160-30 (discussed above), contains no residences, and Site impacts appear based on visual evidence and environmental sampling to be limited to road building activities that have resulted in the placement of relatively small quantities of mine tailings on this parcel.

The least extensive discrete portion of the Mine Area Operable Unit comprises the two parcels located off of the historic mine property (parcel numbers 39-170-66 and 39-170-77). These parcels contain the area along Little Clipper Creek south of the log dam and north of Greenhorn Road where tailings have accumulated (see Figure 5 above). This area is characterized by a narrow band of contamination located on residential property. The two parcels are zoned for residential use and are currently occupied by one single family residence per parcel. The residences are located higher in elevation than, and a considerable distance from (as a consequence of the large parcel sizes), the Little Clipper Creek drainage. Therefore current exposure is considered recreational in nature. The two homes located on these parcels rely on individual residential wells for water supply. One of the wells serving one of the residences has consistently exceeded the MCL for arsenic of 10 ppb and the property owners currently have an installed water treatment system which reduces arsenic levels in the household water supply to levels below the MCL. The other residence is served by an individual well which consistently does not exceed the MCL for arsenic (the property owner drilled this well to replace the original well, which did exceed the MCL for arsenic).

## 6.2 Future Land Use

USEPA envisions future land use as follows for the nine parcels discussed in Section 6.1 above. Any land use restrictions that may be necessary to achieve these uses are discussed as part of Section 9 (Remedial Alternatives) below.

39-160-21: Due to the limited extent of contaminated soil located on this property, it is expected to remain in residential use. Based on the Selected Remedy (see Section 12 below), USEPA believes that following completion of the remedial action there will be no need for future surface use restrictions on this parcel. Whether groundwater use restrictions may be necessary will be determined at the completion of USEPA's ongoing Groundwater Operable Unit Remedial Investigation and Feasibility Study.

39-160-16: Due to the limited extent of contaminated soil located on this property, it is expected to remain in residential use. Based on the Selected Remedy (see Section 12 below), USEPA believes there will be no need for future surface use restrictions on this parcel. Whether groundwater use restrictions may be necessary will be determined at the completion of USEPA's ongoing Groundwater Operable Unit Remedial Investigation and Feasibility Study.

39-160-25: USEPA believes that continued residential use of this parcel would not be consistent with the Selected Remedy (see Section 12) which results in waste being left in place; furthermore the Selected Remedy relies on engineering controls which must be protected from the encroachment and interference that would inevitably result from residential development. Therefore use restrictions will be necessary as discussed in Section 12. USEPA does not expect that the Upper Rental will remain standing because of the combination of its precarious structural condition and its location on top of waste rock and directly adjacent to the tailings disposal area, which places it in the path of earth moving activities, specifically the re-contouring of the waste rock (see Section 12). As discussed previously in this section of the ROD, the issue of groundwater use restrictions is being deferred until the completion of USEPA's ongoing Groundwater Operable Unit Remedial Investigation and Feasibility Study.

39-160-30: USEPA beleves its response action will reduce contaminant levels in soil on this parcel to cleanup goals (see Section 8 below) and that surface use restrictions will not be necessary. Whether groundwater use restrictions may be necessary will be determined at the completion of USEPA's ongoing Groundwater Operable Unit Remedial Investigation and Feasibility Study. Should re-occupation of the residence be made possible, as is expected, by completion of USEPA's Selected Remedy as outlined in this ROD, consistent with USEPA's response action taken in April 2003 (see Section 2), continuation of treatment would be required for groundwater obtained from any well or wells located on the property and used for this residence's water supply.

39-160-27: USEPA believes that due to the limited impact of the Selected Remedy on this parcel, future use of this parcel would be consistent with its current zoning of Residential/Agricultural. A site survey will determine whether the Little Clipper Creek diversion structure which is part of the Selected Remedy crosses this parcel: if so, surface use restrictions would be necessary to protect the integrity of the diversion structure (see Section 12). Whether groundwater use restrictions may be necessary will be determined at the completion of USEPA's ongoing Groundwater Operable Unit Remedial Investigation/ Feasibility Study.

39-160-28: USEPA believes that because this parcel contains the failed log dam, which is due to be replaced by a rock buttress to be located on the same parcel (see Section 12), residential use of this parcel would not be consistent with protection of the physical integrity of the Selected Remedy. Therefore use restrictions would be necessary as discussed in Section 12. As discussed earlier in this section of the ROD, the issue of groundwater use restrictions is being deferred until the completion of USEPA's ongoing Groundwater Operable Unit Remedial Investigation and Feasibility Study.

39-160-29: USEPA believes that due to the limited impact of the Selected Remedy on this parcel, future use of this parcel would be consistent with its current zoning of Residential/Agricultural. It may be necessary to place an asphalt cap over the existing gravel driveway which traverses this parcel: if so, surface use restrictions would be necessary to protect the integrity of the asphalt cap (see Section 12). Whether groundwater use restrictions may be necessary will be determined at the completion of USEPA's ongoing Groundwater Operable Unit Remedial Investigation and Feasibility Study.

39-170-66 and 39-170-77: Due to the limited extent of contaminated sediment located on these properties, they are expected to remain in residential use. Based on the Selected Remedy (see Section 12 below), USEPA believes there will be no need for future surface use restrictions on these two parcels. Whether groundwater use restrictions may be necessary will be determined at the completion of USEPA's ongoing Groundwater Operable Unit Remedial Investigation/Feasibility Study.

# 7 Summary of Site Risks

In 2001, USEPA prepared baseline risk assessments for human health and ecological risk at the Lava Cap Mine Superfund Site, including the Mine Area Operable Unit. The baseline human health risk assessment (HHRA) and ecological risk assessment (ERA) are included as Appendices E and F, respectively, to the Public Release Draft Lava Cap Mine RI Report (USEPA, 2001a).

The risk assessments estimate the human health and environmental risks that the site could pose if no cleanup actions were taken (this is why it is referred to as a baseline risk assessment). They are one of the factors that USEPA considers in deciding whether to take action at a site. The risk assessments are also used to identify the contaminants and exposure pathways that need to be addressed by the remedial action. The HHRA and ERA indicate that multiple completed exposure pathways pose a significant potential risk to human and ecological receptors. This section of the ROD summarizes the results of the risk assessments for the Mine Area Operable Unit.

The Mine Area Operable Unit has experienced historical uses that are industrial in nature, specifically gold and silver mining and ore processing, with some residential use. Mining activity ceased in 1943 and from that point to the present, the surrounding areas have become residential. Due to the wooded nature of the landscape and the presence of surface water features, there are also believed to be recreational uses associated with residential use. The parcels that make up the Mine Area Operable Unit and adjacent parcels are all privately held, therefore recreational exposure would mainly be from residents and, potentially, trespassers. USEPA assessed both human and ecological risks for the Mine Area Operable Unit based on continuation of current residential/recreational land uses and also based on theoretical worker exposure. The latter was evaluated assuming the property would be used as a workplace under current unremediated conditions (given the failures to reopen the mine the assumptions were not for workers actively manipulating the mine workings, waste rock, and tailings, but for incidental contact with these materials while undertaking some other construction-related business). The risk assessments concluded that arsenic presents the primary risk to human and ecological health at the Site. As discussed below, USEPA's HHRA also included lead and iron as contaminants of concern for human exposure. USEPA has posted the Mine Area warning of these risks (See Photo 5). As demonstrated by the facts discussed below, including the Site-specific occurrence and chemical concentration data for chemicals of concern, and the risks associated with completed exposure pathways, the response action selected in this ROD is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

**Photo 6: Warning sign posted by USEPA c. 2003**

# 7.1 Summary of Human Health Risk Assessment

The HHRA was prepared in accordance with USEPA guidance (USEPA Risk Assessment Guidance for Superfund, Parts A-D (RAGS) (USEPA 1989a, 1991b, 1991c, 1991d, 1998a)). The HHRA evaluated risks at the Mine Area Operable Unit to three categories of potentially exposed individuals:

- theoretical regularly employed outdoor workers (there are currently no regularly employed workers);
- residents on the mine property; and
- residents and recreational users of Little Clipper Creek below the mine.

The most significant routes of exposure are through the incidental ingestion of arsenic in soil, sediment, surface water, and airborne dust. Residents are also potentially exposed to risk from ingestion of elevated levels of arsenic in contaminated groundwater. USEPA concluded that conditions at the Mine Area Operable Unit pose unacceptable risks to human health for both cancer and non-cancer risks. The acceptable risk range cited in the NCP for excess cancer risk is between one in ten thousand and one in one million exposed individuals. In contrast, at the Mine Area Operable Unit, the excess lifetime cancer risk (the risk of contracting cancer above and beyond such risks in the general population) was estimated by USEPA to be as high as 1 case per 200 exposed individuals for the theoretical worker scenario and for residents of the mine property. The following sections discuss these conclusions in greater detail.

## 7.1.1 Identification of Chemicals of Concern

As discussed above, in terms of human health risk, arsenic has been identified as the main chemical of concern, along with, for the worker and mine resident scenarios, iron and lead. Table 4 presents the COCs and associated Exposure Point Concentrations. The Exposure Point Concentrations are calculated by applying statistical methods to the data set for contaminant occurrence at the Site, and represent the highest concentration of the contaminant a person could reasonably be expected to encounter at the Site.

Arsenic is a known human carcinogen. It is one of the earth's elements and cannot be destroyed, Because it occurs naturally, it is commonly present in soil, food, and even drinking water. However, the highest levels of arsenic found at the Site by far exceed the amounts that are commonly found in food and drinking water. The most characteristic effect of long term oral exposure to arsenic is a pattern of skin changes such as darkening of the skin or the formation of warts on the palms, soles of the feet, and torso. These changes sometimes develop into cancer. According to the Agency for Toxic Substances and Disease Registry (ATSDR), ingestion of arsenic has been associated with increased risks of cancer of the liver, bladder, kidneys, prostate, and lungs.

Lead is also one of the earth's elements and is naturally present in soil, food, and even drinking water. According to ATSDR, the main target for lead toxicity is the nervous system in both adults and children, although children are considered the more sensitive population. At high levels of exposure lead can severely damage the brain and kidneys in adults and children, and in pregnant women, high levels of exposure may lead to miscarriage. There is currently inadequate evidence to suggest that lead causes cancer in humans.

Iron is also one of the earth's elements and, similar to arsenic and lead, is naturally present in soil, food, and even drinking water. Unlike arsenic and lead, it is widely considered to be an essential nutrient, and serves an important function in the human body for oxygen transport and metabolism. Iron deficiency is common in some subsets of the human population, however, according to the National Institutes of Health, iron overload is also a potential problem in which excess iron is stored in the organs such as the liver and the heart, with the potential to damage those organs. There is no evidence to suggest that iron causes cancer in humans.

| Exposure Point | Chemical of Concern | Frequency of Detection | Units | Minimum Concentration | Maximum Concentration | Exposure Point Concentration | Statistical Measure |
|---|---|---|---|---|---|---|---|
| **Mine Area Soil - Potential Future Worker** | | | | | | | |
| | Arsenic | 29/29 | ppm | 63.9 | 31,200 | 13,000 | 95% UCL |
| | Lead | 29/29 | ppm | 11.4 | 2,320 | 1,180 | 95% UCL |
| | Iron | 29/29 | ppm | 5,090 | 146,000 | 70,400 | 95% UCL |
| **Mine Area Soil - Current Resident** | | | | | | | |
| | Arsenic | 23/23 | ppm | 4.7 | 1,750 | 1,750 | Maximum |
| | Iron | 23/23 | ppm | 9,720 | 58,400 | 40,000 | 95% UCL |
| **Mine Area Groundwater- Current Resident** | | | | | | | |
| | Arsenic | 5/5 | ppb | 11.2 | 56.8 | 56.8 | Maximum |
| **Little Clipper Creek Soil/Sediment - Current Resident/Recreational User** | | | | | | | |
| | Arsenic | 12/12 | ppm | 53.9 | 1,150 | 749 | 95% UCL |
| **Little Clipper Creek Surface Water - Current Resident/Recreational User** | | | | | | | |
| | Arsenic | 14/14 | ppb | 19 | 285 | 162 | 95% UCL |
| **Little Clipper Creek Groundwater - Current Resident/Recreational User** | | | | | | | |
| | Arsenic | 3/3 | ppb | 28.5 | 46.3 | 46.3 | 95% UCL |
| Notes:<br>ppm= mg/kg<br>ppb = ug/L<br>95% UCL = 95 percent upper confidence limit | | | | | | | |

**Table 4: Contaminants of Concern and Exposure Point Concentrations**

## 7.1.2 Exposure Assessment

Exposure refers to the potential contact of an individual (sometimes referred to as a receptor) with a chemical. Exposure assessment is the determination or estimation of the magnitude, frequency, duration, and route of potential exposure. The exposure assessment methodology used in the baseline risk assessment follows the procedures outlined in Chapter 6 of RAGS, Part A (USEPA, 1989a). This section briefly summarizes the potentially exposed populations, the exposure pathways evaluated, and the exposure quantification from the HHRA performed for the Mine Area Operable Unit. Considerably more detail on the exposure assessment can be found in the Appendix E of the RI Report (USEPA, 2001a).

As discussed briefly in Section 7.1 above, the exposure assessment for the Mine Area was divided into three components: outdoor worker exposure within the areas of the historic mine buildings and the waste rock and tailings disposal areas; residential exposure at parcels directly adjacent to the historic mine buildings and waste rock/tailings disposal areas; and residential/recreational use along Little Clipper Creek between the log dam and Greenhorn Road.

For the outdoor worker exposure scenario, a 25-year exposure duration was assumed. The primary exposure pathway was incidental ingestion of, dermal contact with, and inhalation of, surface soil and sediment in the waste rock and tailings disposal areas, and in and around the mine buildings. Ingestion of contaminated groundwater was not included as a pathway because it was assumed that the water would be treated prior to consumption or an alternative drinking water supply would be included for the duration of the working day.

For the residential exposure scenario at the mine, the assumption was made that residents would be exposed to surface soil in areas adjacent to, but not in, the mine buildings and the waste rock and tailings disposal areas. Exposure pathways include ingestion of soil, dermal contact with soil, and inhalation of suspended particulates. Also included was ingestion of groundwater from private wells and dermal contact with well water through showering (to reduce the potential for current exposure, the former pathway has been mitigated through the installation of water filtration units on residential water supplies exceeding the MCL for arsenic).

For the residential/recreational use exposure scenario along Little Clipper Creek downstream of the mine, exposure pathways included ingestion of soil or sediment, inhalation of suspended particulates, and dermal contact with and incidental ingestion of surface water while wading (the depth of Little Clipper Creek is not such that it supports recreational swimming). Also included was ingestion of groundwater from private wells and dermal contact with well water through showering (again, the former has been mitigated through the installation of water filtration units on residential water supplies exceeding the MCL for arsenic).

For each of these exposure scenarios, intakes were evaluated for noncarcinogenic health effects in terms of the average daily dose that would result from exposure. The intakes of chemicals evaluated for carcinogenic health effects was based on the lifetime average daily dose (the lifetime average daily dose is calculated by prorating the total cumulative dose of the chemical over an entire lifespan, assumed to be 70 years).

### 7.1.3 Toxicity Assessment

The toxicity assessment seeks to develop a reasonable appraisal of associations between the degree of exposure to a chemical and the possibility of adverse health effects. It consists of two components: hazard identification (the process of determining what adverse human health effects, if any, could result from exposure to a particular chemical); and dose-response evaluation (a quantitative examination between the level of exposure and the probability of adverse health effects in an exposed population). The toxicity assessment identifies chemical-specific toxicity factors for each COC for the purpose of determining individual and cumulative noncancer (i.e., Hazard Quotients [HQs]) and cancer (i.e., Excess Lifetime Cancer Risk [ELCR]) risk values for the HHRA.

The toxicity value used to evaluate potential noncancer (i.e., noncarcinogenic) effects is the reference dose (RfD). The RfD has been developed by USEPA based on the assumption that thresholds exist for certain toxic effects. In other words, a certain amount (i.e., dose) of the chemical is required to be ingested, inhaled or absorbed through the skin to produce an undesirable noncancer health effect. In general, the RfD is an estimate of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without a significant risk of noncancerous effects during a lifetime. RfDs for the COCs at Lava Cap Mine are presented in Table 5.

**Table 5**
**Cancer and Non-Cancer Toxicity Data Summary**
*Lava Cap Mine Site - Mine Area OU ROD*

**Cancer Toxicity Data Summary**

**Pathway: Inhalation**

| Chemical of Concern | Unit Risk | Units | Adjustment | Inhalation Cancer Slope Factor | Units | Weight of Evidence/Cancer Guideline Description | Source | Date (1) (MM/DD/YY) |
|---|---|---|---|---|---|---|---|---|
| Arsenic | 4.3 x 10(-3) | (ug/cu m)-1 | 3,500 | 1.5 x 10(+1) | (mg/kg/day)-1 | A | IRIS | 11/03/2000 |
| Lead | 1.2 x 10(-5) | (ug/cu m)-1 | 3,500 | 4.2 x 10(-2) | (mg/kg/day)-1 | B2 | IRIS | 11/03/2000 |

**Pathway: Oral/Dermal**

| Chemical of Concern | Oral Cancer Slope Factor | Oral to Dermal Adjustment Factor | Adjusted Dermal Cancer Slope Factor (2) | Units | Weight of Evidence/Cancer Guideline Description | Source | Date (1) (MM/DD/YY) |
|---|---|---|---|---|---|---|---|
| Arsenic | 1.5 | 100.00% | 1.5 | (mg/kg/day)-1 | A | IRIS | 11/03/2000 |
| Lead | 8.5 x 10(-3) | 100.00% | 8.5 x 10(-3) | (mg/kg/day)-1 | B2 | IRIS | 11/03/2000 |

IRIS = Integrated Risk Information System

(1) The date IRIS was searched.
(2) Adjusted Dermal Cancer Slope Factor = Oral Cancer Slope factor divided by the Oral-to-Dermal Adjustment factor.

EPA Group:
A - Human carcinogen
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans

**Non-Cancer Toxicity Data Summary**

**Pathway: Oral/Dermal**

| Chemical of Concern | Chronic/ Subchronic | Oral RfD Value | Oral RfD Units | Dermal RfD (2) | Units | Primary Target Organ | Combined Uncertainty Modifying Factors | Sources of RfD: Target Organ | Dates (1) (MM/DD/YY) |
|---|---|---|---|---|---|---|---|---|---|
| Arsenic | Chronic | 3.0 x 10(-4) | mg/kg/day | 3.0 x 10 (-4) | mg/kg/day | Skin | 3 | IRIS:NCEA | 11/3/2000- IRIS 2/1/1993- NCEA |
| Iron | Chronic | 3.0 x 10(-1) | mg/kg/day | 3.0 x 10(-1) | mg/kg/day | NA | NA | NCEA | Oct-99 |

NA = Not Applicable

(1) For IRIS values, this is the date IRIS was searched. For NCEA, the date of the article is provided.

(2) Dermal RfD = Oral RfD Value x Oral-to-Dermal Adjustment factor (100% for these COCs)

Toxicity values have also been developed for evaluating potential human carcinogenic effects from exposure to carcinogens. Potential human carcinogenic effects are evaluated using chemical-specific slope factors and an accompanying USEPA weight-of-evidence determination. Slope factors have been derived by USEPA (and are published in the Integrated Risk Information System (IRIS) (USEPA, 1997) or the Health Effects Assessment Summary Tables (HEAST) (USEPA, 1998)) based on the concept that for any exposure to a carcinogenic chemical there is always a carcinogenic response (i.e., no threshold level exists). Slope factors are used in risk assessment to estimate an upper-bound lifetime probability of an individual developing cancer as a result of a specific exposure to a carcinogen.

USEPA has identified a carcinogenic classification system that uses a weight of the evidence approach to classify the likelihood of a chemical being a human carcinogen. Arsenic has been assigned to Class A, known human carcinogen. The carcinogenic oral slope factors (toxicity values) for the Lava Cap Mine COCs are shown in Table 5.

### 7.1.4 Risk Characterization

This section presents the results of the evaluation of the potential risks to human health associated with exposure to contaminated soil, sediment, surface water and groundwater at the Mine Area Operable Unit of the Lava Cap Mine Superfund Site. By taking the exposure scenarios and applying the approach from the toxicity assessment, USEPA arrived at a characterization of potential health risks to workers, residents at the mine, and residential/recreational use along Little Clipper Creek between the mine and Greenhorn Road.

For carcinogens, risks are generally expressed as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the carcinogen, in this case- arsenic. Excess lifetime cancer risk or ELCR is calculated from the following equation:

$$\text{ELCR} = \text{Chronic Daily Intake} \times \text{Slope Factor}$$

Chronic daily intake is the amount of contaminant-specific chemical exposure averaged over 70 years and is in the units mg/kg-day. The slope factor is based on research data and is a representation of the escalation of cancer risk with increasing exposure to a specific contaminant. These risks are probabilities that usually are expressed in scientific notation (e.g., $1 \times 10^{-6}$). An excess lifetime cancer risk of $1 \times 10^{-6}$ indicates that an individual has a 1 in 1,000,000 chance of developing cancer as a result of site-related exposure. This is referred to as an "excess lifetime cancer risk" because it would be in addition to the risks of cancer individuals face from other causes such as smoking or exposure to too much sun. Data collected by public health agencies indicate the chance of an individual developing cancer from all other causes has been estimated to be as high as 1 in 3. USEPA's generally acceptable risk range for site-related exposures is $10^{-4}$ to $10^{-6}$. An ELCR of greater than one in ten thousand ($1 \times 10^{-4}$) is the point at which action is generally required at a site (USEPA, 1991a).

The potential for noncarcinogenic effects is evaluated by comparing an exposure level over a specified time period (e.g., a lifetime) with a reference dose (derived from research data) for a similar exposure period. The ratio of exposure level to the reference dose is called a hazard quotient or HQ and is represented by the following equation:

$$\text{Noncancer Hazard Quotient} = \text{Chronic Daily Intake} \div \text{Reference Dose}$$

An HQ less than one indicates that a receptor's dose of a single contaminant is less than the reference dose and that toxic noncarcinogenic effects from exposure to that contaminant are unlikely. HQs for all

COCs that affect the same target organ (e.g., liver) are added together to generate the Hazard Index (HI). An HI less than one indicates that noncarcinogenic effects from all the contaminants are unlikely. Conversely, an HI greater than one indicates that site-related exposures may present a risk to human health.

Several assumptions used in the HHRA evaluation contribute uncertainty to the risk assessment. These uncertainties are common to the risk assessment process and are not specific to the Mine Area Operable Unit. Some may result in underestimation of risk, others in overestimation of risk. The methods employed in preparing the HHRA for the Mine Area Operable Unit followed current guidance. Some of the key areas of uncertainty include:

The risks calculated depend largely on the assumptions used to calculate the level of contaminant intake. For this assessment, reasonable maximum exposure (RME) values are used. The use of these RMEs makes it likely that the risk is not underestimated, and may in fact be overestimated. In addition, the amount of each of the constituents that might be absorbed into the body may be quite different from the amount of chemical that is actually contacted (i.e., due to bioavailability). In this assessment, bioavailability of ingested and inhaled chemicals is conservatively assumed to be 100 percent. Actual chemical- and site-specific values are likely to be much less than this conservative default value.

There is uncertainty associated with the exposure pathways and exposure assumptions used in the exposure assessment. The selection of exposure pathways is a process, often based on professional judgment, that attempts to identify the most probable potentially harmful exposure scenarios. Key factors include the specific exposure pathways and durations developed in the conceptual site model (see Section 5.4). These factors may overestimate the amount of time a receptor spends in a particular pathway. However, risks are sometimes not calculated for each and every potential exposure pathway that may occur, possibly causing some underestimation of risk.

Many factors contribute to the uncertainty of dermal route exposure in risk assessment. There are uncertainties associated with each of the input parameters used in the equations to describe risk. Additional uncertainties originate from factors that are not sufficiently characterized to be included in the risk equations. These include issues related to the degree and uniformity with which soil adheres to skin, exposed body surfaces, the frequency and duration of exposure, and the rate and amount of contaminant absorption.

The availability and quality of toxicological data is another source of uncertainty in the risk assessment. Uncertainties associated with animal and human studies may have influenced the toxicity criteria. Carcinogenic criteria are classified according to the amount of evidence available that suggests human carcinogenicity. USEPA assigns each carcinogen a designation of A through E, dependent upon the strength of the scientific evidence for carcinogenicity (USEPA, 1989a). Arsenic has been designated as a known human carcinogen (Class A), but there is considerable uncertainty in many of the carcinogenic and non-carcinogenic factors used. This could lead to either under- or overestimation of risks, although the conservative factors used in the process make it fairly unlikely that risks will be underestimated.

## Table 6
## Risk Characterization Summary - Carcinogenic and Noncarcinogenic
*Lava Cap Mine Site - Mine Area OU ROD*

| Medium | Exposure Medium | Exposure Point | Chemical | Carcinogenic Risk: Ingestion | Carcinogenic Risk: Inhalation | Carcinogenic Risk: Dermal | Carcinogenic Risk: Exposure Routes Total | Chemical | Non-Carcinogenic Hazard Quotient: Primary Target Organ | Non-Carcinogenic Hazard Quotient: Ingestion | Non-Carcinogenic Hazard Quotient: Inhalation | Non-Carcinogenic Hazard Quotient: Dermal | Non-Carcinogenic Hazard Quotient: Exposure Routes Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scenario Timeframe: Future(2); Receptor Population: Mine Worker; Receptor Age: Adult | | | | | | | | | | | | | |
| Soil | Surface Soil | Surface soil in Source Areas | Arsenic | 3.43E-03 | -- | 1.33E-03 | 4.8E-03 | Arsenic | Skin | 22 | -- | 8.4 | 30 |
| | | | Lead | 1.78E-06 | -- | 2.29E-06 | 4.1E-06 | Lead | -- | -- | -- | -- | -- |
| Soil | Air | Emissions from surface soil in Source Areas | Arsenic | -- | 6.75E-04 | -- | 6.8E-04 | Arsenic | Skin | -- | -- | -- | -- |
| | | | Lead | -- | 1.70E-07 | -- | 1.7E-07 | Lead | -- | -- | -- | -- | -- |
| | | | Soil Total (1) | | | | 5.4E-03 | Soil Total (1) | | -- | -- | -- | 31 |
| | | | Total Risk Across All Media and All Exposure Routes | | | | 5.4E-03 | Total Hazard Index Across All Media and All Exposure Routes | | | | | 31 |
| | | | | | | | | | | | | Total Skin HI = | 30 |
| Scenario Timeframe: Current; Receptor Population: Resident; Receptor Age: Adult/Child(3) | | | | | | | | | | | | | |
| Groundwater | Groundwater | Mine Area residential tap water | Arsenic | 1.28E-03 | -- | 1.57E-05 | 1.3E-03 | Arsenic | Skin | 5.2 | -- | -- | 5.2 |
| | | | GW Total (1) | | -- | | 1.3E-03 | GW Total (1) | | | | | 7.0 |
| Soil | Surface Soil | Surface soil around Mine Area residences | Arsenic | 4.10E-03 | -- | 3.89E-04 | 4.5E-03 | Arsenic | Skin | 75 | -- | 6.3 | 81 |
| | | | Lead | 6.97E-07 | -- | 2.21E-07 | 9.2E-07 | Lead | -- | -- | -- | -- | -- |
| | | | Iron | -- | -- | -- | -- | Iron | -- | 1.7 | -- | -- | 1.7 |
| Soil | Air | Emissions from surface soil around Mine Area residences | Arsenic | -- | 2.95E-06 | -- | 3.0E-06 | Arsenic | Skin | -- | -- | -- | -- |
| | | | Lead | -- | 2.48E-10 | -- | 2.5E-10 | Lead | -- | -- | -- | -- | -- |
| | | | Soil Total (1) | | | | 4.5E-03 | Soil Total (1) | | -- | -- | -- | 84 |
| | | | Total Risk Across All Media and All Exposure Routes | | | | 5.8E-03 | Total Hazard Index Across All Media and All Exposure Routes | | | | | 91 |
| | | | | | | | | | | | | Total Skin HI = | 86.5 |
| Scenario Timeframe: Current; Receptor Population: Resident w/Recreational Activities at LCC; Receptor Age: Adult/Child(3) | | | | | | | | | | | | | |
| Groundwater | Groundwater | LCC residential tap water | Arsenic | 1.1E-03 | -- | 2.10E-06 | 1.05E-03 | Arsenic | Skin | 4.2 | -- | 0.02 | 4.2 |
| | | | GW Total (1) | | -- | | 1.1E-03 | GW Total (1) | | | | | 5.3 |
| Soil/Sediment | Soil/Sediment | Contact with surface soil/sediment during recreation along LCC | Arsenic | 4.80E-04 | -- | 4.95E-05 | 5.3E-04 | Arsenic | Skin | 9.2 | -- | 0.8 | 10 |
| Soil/Sediment | Air | Emissions from surface soil/sediment during recreation along LCC | Arsenic | -- | 3.80E-07 | -- | 3.8E-07 | Arsenic | Skin | -- | -- | -- | -- |
| | | | Soil Total (1) | | -- | | 5.3E-04 | Soil Total (1) | | | | | 11 |
| Surface Water | Surface Water | Recreational contact with LCC surface water | Arsenic | -- | -- | 1.10E-05 | 1.1E-05 | Arsenic | Skin | -- | -- | 0.032 | 0.032 |
| | | | SW Total (1) | | | | 1.1E-05 | SW Total (1) | | | | | 0.034 |
| | | | Total Risk Across All Media and All Exposure Routes | | | | 1.6.E-03 | Total Hazard Index Across All Media and All Exposure Routes | | | | | 16 |
| | | | | | | | | | | | | Total Skin HI = | 14.2 |

(1) The total risk values include all constituents evaluated in the HHRA, not just the COCs that are listed on this table. The HHRA (Appendix E in EPA, 2001a) provides details for all constituents.

(2) Future exposure is hypothetical and not expected to actually occur. It is evaluated for risk assessment purposes only.

(3) The Adult/Child receptor age- assumes 6 years of exposure as a child followed by 24 years of exposure as an adult.

(4) The notation E refers to exponential notation. For example 1.6 E -03 is equivalent to 1.6 x 10(-3) which is equivalent to 1/1.6 x 10(+3) or 1/1600

### 7.1.5 HHRA Results

Table 6 presents the risk characterization summaries for carcinogenic and noncarcinogenic effects. The risk estimates presented in this table are based on reasonable maximum exposure (RME) and were developed by taking into account conservative assumptions about the frequency and duration of exposure, as well as the toxicity of the primary COCs (see the HHRA for more detail).

Risks due to outdoor worker exposure in the Mine Area are estimated as follows: The excess lifetime cancer risk or ELCR is estimated at $5.4 \times 10^{-3}$ or one excess cancer in a population of 185 individuals. This exceeds the acceptable risk range of $1 \times 10^{-4}$ to $1 \times 10^{-6}$ cited in the NCP. The hazard index or HI represents a measure of the magnitude of non-cancer risks (an HI of 1 is the benchmark above which non-cancer risks begin to be considered significant) and is estimated at 31.

Risks due to residential exposure in the Mine Area are estimated as follows: The ELCR is estimated at $5.8 \times 10^{-3}$ or one excess cancer in a population of 172 individuals. This exceeds the acceptable risk range of $1 \times 10^{-4}$ to $1 \times 10^{-6}$ cited in the NCP. The HI is estimated at 91. These risks include risks from drinking groundwater with elevated levels of arsenic.

Risks due to residential/recreational use along Little Clipper Creek are estimated as follows. The ELCR is estimated at $1.6 \times 10^{-3}$ or one excess cancer in a population of 625 individuals. This exceeds the acceptable risk range of $1 \times 10^{-4}$ to $1 \times 10^{-6}$ cited in the NCP. The HI is estimated at 16. These risks include risks from drinking groundwater with elevated levels of arsenic.

Based on the risk characterization results shown in Table 6, which demonstrate cancer and noncancer risks to residents and future workers in the Mine Area OU , USEPA has determined that actual or threatened releases of hazardous substances at this site, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment.

## 7.2 Summary of Ecological Risk Assessment

To assist in understanding potential impacts to the environment at the Mine Area Operable Unit, some discussion of biota representative of the Sierra Nevada foothills is also warranted here. The area is characterized by the Ponderosa Pine plant community. While Ponderosa pine dominates, Douglas fir, incense cedar, and scattered interior live oak are present along with various shrubs and ground covers in the understory. Little Clipper Creek supports the Valley Foothill Riparian vegetation type, which has similar overstory trees but also includes Oregon ash and white alder and exhibits different understory species. Disturbed areas, such as the waste rock and tailings piles and the areas around the abandoned mine buildings, contain a number of native and non-native (weedy) plant species associated with these habitat types. Little Clipper Creek supports small rainbow trout as well as a few larger brown trout. The California red-legged frog, a federally designated threatened species and a California species of special concern, was reported in an onsite wetland in 1985 but was not found in a 1995 survey. Western skink and gopher snakes are common reptiles observed onsite, and several other reptiles species are likely present. The Mine Area's different habitat types support a variety of birds and mammals (see Table 7). The California Department of Fish and Game's Wildlife Habitat Relationships System indicates that several special-status wildlife species could potentially occupy habitats in the area.

The ERA evaluated risks from Site-related contaminants to fish, sediment biota, amphibians, terrestrial plants, soil invertebrates, soil microbial processes, and several species of birds and mammals.

In the exposure assessment, exposure estimates were calculated for the above categories of ecological receptors. Both internal and external exposure routes exist for these classes of receptors. Internal exposure routes pertain to accumulative concentrations of chemicals measured in body tissues or back-calculated from chemical concentrations in contaminated media. External exposure routes pertain to direct dermal contact, inhalation and ingestion of chemicals measured in contaminated media.

In the effects assessment, potential adverse health effects associated with exposure to COCs (see Table 8) were identified. Literature derived single chemical toxicity data, ambient media toxicity tests, and biological field survey data were all utilized to draw the conclusions reached.

| Bird Species Potentially Present | Mammal Species Potentially Present | |
|---|---|---|
| ducks (various) | bats (various) | coyote |
| great blue heron | Virginia opossum | bobcat |
| great egret | vagrant and ornate shrew | mountain lion |
| osprey | broad-footed mole | black bear |
| bald eagle | black-tailed jackrabbit | |
| sharp-shinned hawk | western gray squirrel | |
| Cooper's hawk | Douglas' squirrel | |
| northern goshawk | deer mouse | |
| long-eared owl | dusky-footed woodrat | |
| blue grouse | California vole | |
| mountain quail | common muskrat | |
| band-tailed pigeon | wild pig | |
| mourning dove | mule deer | |
| northern flicker | western spotted skunk | |
| willow flycatcher | striped skunk | |
| yellow warbler | ringtail | |
| California towhee | American martin | |
| dark-eyed junco | fisher | |
| Merlin | ermine | |
| California quail | long-tailed weasel | |
| loggerhead shrike | American mink | |
| song sparrow | gray fox | |

**Table 7: Bird and Mammal Species Potentially Present in the Mine Area OU**

Conservative estimates of exposure for each class of receptors were compared with literature derived ecotoxicity screening values as well as Site-specific toxicity thresholds where available. Results of Site-specific ambient media toxicity bioassays and biological surveys were used as additional lines of evidence in the risk characterization evaluation.

The results of the risk characterization for the Mine Area are summarized in Table 8. As can be seen, the ecological risk assessment concludes that various species are expected to be adversely affected by arsenic, cyanide, and metals in contaminated media at the Site. In performing this assessment, USEPA

| Receptor | Ag | As | Ba | Be | Cd | CN | Co | Cu | Hg | Mn | Ni | Pb | Sb | Se | Zn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fish | yes | yes | yes | yes | yes | yes | yes | yes | yes | yes | yes | yes | yes | | yes |
| Amphibians | yes | yes | | | | | | yes | yes | yes | yes | yes | | | yes |
| Sediment Biota | yes | yes | | | yes | | | yes | yes | | | yes | yes | yes | |
| Terrestrial Plants | yes | yes | | | yes | yes | yes | yes | yes | | | yes | yes | yes | yes |
| Earthworms | yes | yes | | | yes | yes | yes | yes | yes | | | yes | yes | yes | yes |
| Microbes | yes | yes | | | yes | | | yes | | | yes | yes | | | yes |
| American Dipper | | yes | | | | | yes | yes | yes | yes | | yes | | yes | |
| Green Heron | | yes | | | | | | | | | | | | | |
| California Quail | | yes | | | | | | | | | | | | | |
| California Vole | | yes | | | | yes | | | | | | yes | | | |
| Mink | | yes | | | | | | | | | | | | | |
| Ornate Shrew | | yes | | | | yes | | | | | | yes | yes | | |
| Long-Tailed Weasel | | yes | | | | | | | | | | | | | |

Notes:
Ag- Silver
As- Arsenic
Ba- Barium
Be- Beryllium
Cd- Cadmium
CN- Cyanide
Co- Cobalt
Cu- Copper
Hg- Mercury
Mn- Manganese
Ni- Nickel
Pb- Lead
Sb- Antimony
Se- Selenium
Zn- Zinc

**Table 8: Potential for Risks to Ecological Receptors**

selected a number of birds and mammals as the most representative of, or those that may feed and live on, the Mine Area Operable Unit and are assumed to forage in close association with contaminated media on Site, specifically:

- The American dipper, a bird that feeds on aquatic biota, has a small range, and is maximally exposed to sediment and surface water.

- The green heron, which feeds on a variety of aquatic and terrestrial biota and may have a small home range.

- The California quail, which feeds on herbaceous material and occasional arthropods and has a small home range.

- The California vole, a small mammal herbivore with a small home range.

• The mink, a small mammal that preys on a variety of terrestrial and aquatic biota.

• The ornate shrew, assumed to be sensitive due to its close association with soil, small home range, and high ingestion rate as compared to a small body weight and preys on a wide variety of invertebrates.

• The long-tailed weasel, a small terrestrial carnivore with a high ingestion rate and a small home range.

# 8 Remedial Action Objectives

The goals of a Superfund cleanup are called remedial action objectives (RAOs). RAOs provide a general description of what the cleanup will accomplish and serve as the design basis for the cleanup alternatives. Specific RAOs developed for the Mine Area Operable Unit are:

- protect against exposures to contaminants in soil, sediment, and surface water via ingestion, inhalation, or direct contact that present an unacceptable risk to human health;
- remediate contaminants that exceed cleanup goals in soils, sediments, and surface water to the extent technically and economically feasible;
- restore Little Clipper Creek to its beneficial use as a potential drinking water supply;
- protect ecological receptors from exposure to contaminants in soils, sediments, and surface water, that pose a significant risk;
- minimize the potential for migration of contaminants in soil and sediment that pose a threat to the beneficial uses of groundwater and surface water;
- minimize the potential for release of contaminated tailings during a seismic event producing 60 percent of peak ground acceleration or 0.3 g (i.e. three-tenths the force of gravity); and
- minimize the potential for release of contaminated soils and sediments during surface water flow events up to the 100-year return frequency event.

To achieve RAOs, USEPA typically sets numeric cleanup goals for the contaminated media and design criteria for treatment and containment facilities. These and other aspects of the cleanup are governed by the results of the human health and ecological risk assessments and also upon regulatory requirements that are either directly applicable to the Site, or are relevant and appropriate to the conditions at the Site. These regulatory criteria are called Applicable or Relevant and Appropriate Requirements or ARARs. USEPA has developed a list of ARARs for the Mine Area Operable Unit (see Tables 17, 18, and 19 in Section 13).

| Media | Arsenic Cleanup Goal | Basis for Goal |
|---|---|---|
| Surface Water | 10 ppb | MCL (based on potential beneficial use of surface water as drinking water supply) |
| Surface Soil | 20 ppm | Background Concentration (ensures cleanup to naturally-occurring levels in the surrounding environment) |
| Sediment | 25 ppm | Background Concentration (ensures cleanup to naturally-occurring levels in the surrounding environment) |

**Table 9: Cleanup Goals**

For the Mine Area Operable Unit, the arsenic cleanup goals (see Table 9) that have been determined by USEPA to be protective of human health and the environment and to meet ARARs are 10 ppb for surface water; 25 ppm in sediment; and 20 ppm in soil. The selected cleanup goals will ensure that the remedial action reduces human health and ecological risks from the Site to acceptable levels, specifically, post-cleanup lifetime excess cancer risks for all exposure scenarios will fall within the acceptable risk range of 1 x $10^{-4}$ to 1 x $10^{-6}$ set in the NCP. For the Mine Area OU, the cleanup goal for surface water is set at the federal MCL for arsenic of 10 ppb, which is protective of the potential beneficial use of drinking water supply. The cleanup goals for sediment and soil are set at the respective background levels of arsenic found local to the Site in these media (see Section 5 for a discussion of how these background values were developed). It is not technically practicable to clean up a contaminant to levels lower than those present in the surrounding native soil and sediment and the cleanup goals selected meet USEPA's protectiveness criteria.

USEPA has also determined that implementing these cleanup goals focusing on arsenic as the primary COC will be protective of human health for all COCs, because the other constituents co-occur with arsenic in all areas impacted by mining waste. Furthermore, USEPA has determined that the cleanup goals selected based on human health criteria will be protective of ecological receptors, again, because they address all media and areas impacted by mining waste, and because all COCs whether designated for human or ecological receptors will be cleaned up to background levels. Compliance with cleanup goals will be determined using the results of post-excavation, confirmation soil sampling. To confirm that cleanup to background levels has been achieved, the post-excavation sampling data set will be compared to the background data set using statistical techniques. USEPA has developed a guidance document that will be used to assist in conducting this statistical comparison: *Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites/USEPA 540-R-01-003/September 2002* (USEPA, 2002a).